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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE **TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371**		ATTORNEY'S DOCKET NUMBER 1454.1215 10/030704
INTERNATIONAL APPLICATION NO. PCT/DE00/02178	INTERNATIONAL FILING DATE 4 July 2000	PRIORITY DATE CLAIMED 13 July 1999

TITLE OF INVENTION
METHOD FOR CONTROLLING THE TRANSMITTING POWER IN A RADIO COMMUNICATIONS SYSTEM

APPLICANT(S) FOR DO/EO/US
Markus DILLINGER et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.
2. ☒ This is an express request to immediately begin national examination procedures (35 U.S.C. 371(f)).
3. ☒ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
4. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
5. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
6. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
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   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
7. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
8. ☐ An oath or declaration of the inventor (35 U.S.C. 371(c)(4)).
9. ☒ A translation of the Annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 10-15 below concern document(s) or information included:

10. ☒ An Information Disclosure Statement Under 37 CFR 1.97 and 1.98.
11. ☐ An assignment document for recording.
    Please mail the recorded assignment document to:
    a. ☐ the person whose signature, name & address appears at the bottom of this document.
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12. ☒ A preliminary amendment.
13. ☐ A substitute specification
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15. ☐ Other items or information: First page of published International Application; International Preliminary Examination Report; and International Search Report.

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CLAIMS	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
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PATENT TRADEMARK OFFICE

SUBMITTED BY: STAAS & HALSEY LLP			
Type Name	Mark J. Henry	Reg. No.	36,162
Signature	Mark Henry	Date	Jan. 14, 2002

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Docket No.: 1454.1215

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

Markus DILLINGER et al.

Serial No. (PCT/DE00/02178) Group Art Unit: (unassigned)

Confirmation No.

Filed: (concurrently) Examiner: (unassigned)

For: METHOD FOR CONTROLLING THE TRANSMITTING POWER IN A RADIO COMMUNICATIONS SYSTEM

10030704 .031502

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Before examination of the above-identified application, please amend the application as follows:

IN THE CLAIMS:

Please REPLACE claims 2-21 in accordance with the following:

2. (ONCE AMENDED) The method as claimed in claim 1, characterized in that the transmitting power interval (Pint) is defined by a maximum transmitting power (Pmax) and a minimum transmitting power (Pmin).

3. (ONCE AMENDED) The method as claimed in claim 1, characterized in that the transmitting power interval (Pint) is defined individually for the subscriber station (UE) and/or for the base station (NB).

4. (ONCE AMENDED) The method as claimed in claim 1,

characterized in that transmitting power intervals (Pint) of a number of subscriber stations (UE) which have set up connections in parallel in the same frequency band (B) and/or in the same timeslot (ts), are dimensioned in such a manner that a predetermined dynamic range of a receiving device of the base station (NB) is not exceeded.

5. (ONCE AMENDED) The method as claimed in claim 1, characterized in that the base station (NB) signals to the subscriber station (UE) the transmitting power interval (Pint) or the maximum transmitting power (Pmax) and the minimum transmitting power (Pmin) for the signal transmission in the uplink (UL).

6. (ONCE AMENDED) The method as claimed in claim 1, characterized in that the transmitting power interval (Pint) is dimensioned in dependence on a service transmitted over the link between the base station (NB) and the subscriber station (NB).

7. (ONCE AMENDED) The method as claimed in claim 1, characterized in that the transmitting power interval (Pint) is dimensioned in dependence on a speed (V) of the subscriber station (UE).

8. (ONCE AMENDED) The method as claimed in claim 1, characterized in that the transmitting power interval (Pint) is progressively reduced with increasing speed (V) of the subscriber station (UE).

9. (ONCE AMENDED) The method as claimed in claim 7, characterized in that the speed (V) of the subscriber station (UE) is estimated from measurements with respect to a variation of transmission characteristics of the radio interface, the transmission characteristics being determined by means of a characteristic value (BER).

10. (ONCE AMENDED) The method as claimed in claim 9, characterized in that a bit error rate, a time frame error rate, a path attenuation and/or an interference at the location of the subscriber station (UE) is determined as the characteristic value (BER) for the transmission characteristics.

11. (ONCE AMENDED) The method as claimed in claim 9, characterized in that the variation of the characteristic value (BER) of a signaling channel (BCCH) transmitted with constant transmitting power by the base station (NB) is determined in the subscriber station (UE).

12. (ONCE AMENDED) The method as claimed in claim 9, characterized in that the characteristic value (BER) is averaged over a particular time interval and the averaged characteristic value (BERavg) is taken into consideration for the dimensioning of the transmitting power interval (Pint).

13. (ONCE AMENDED) The method as claimed in claim 12, characterized in that the time interval for averaging corresponds to a periodicity of the slow transmitting power control in the outer control loop.

14. (ONCE AMENDED) The method as claimed in claim 9,

characterized in that an updating of the dimensioning of the transmitting power interval (Pint) is initiated when the variation of the transmission characteristics of the radio interface determined drops below a predetermined threshold value.

15. (ONCE AMENDED) The method as claimed in claim 1, characterized in that the fast and/or slow transmitting power control for the uplink (UL) and/or for the downlink (DL) are based on the determination of a carrier/interference ratio (CIR).

16. (ONCE AMENDED) The method as claimed in claim 9, characterized in that the characteristic value (BER) determined is compared with a target BER in the outer control loop and a difference (dBER) between the values is calculated.

17. (ONCE AMENDED) The method as claimed in claim 16, characterized in that the difference (dBER) between the characteristic value (BER) determined and the target BER is weighted by a weighting factor (g).

18. (ONCE AMENDED) The method as claimed in claim 17, characterized in that the weighted difference (dCIR) is added to a target CIR(i) of a preceding control interval (i) from which the current target CIR, CIR(i+1) for the current control interval (i+1) is determined.

19. (ONCE AMENDED) The method as claimed in claim 18, characterized in that the outer control loop for the subscriber station (UE) is also implemented in the base station (NB), in which arrangement an in each case current target CIR is generated in the outer control loop from a current characteristic value (BER) determined by the subscriber station (UE) and signaled to the base station (NB), and is signaled to the subscriber station (UE).

20. (ONCE AMENDED) The method as claimed in claim 1, characterized in that the radio communications system supports a TDD transmission method.

21. (ONCE AMENDED) The method as claimed in claim 1, characterized in that the radio communications system supports an FDD transmission method.

REMARKS

This Preliminary Amendment is submitted to improve the form of the specification as originally-filed. No new matter is added to these documents.

It is respectfully requested that this Preliminary Amendment be entered in the above-referenced application.

If any further fees are required in connection with the filing of this Preliminary Amendment, please charge same to our Deposit Account No. 19-3935.

Respectfully submitted,

STAAS & HALSEY LLP

Date: Jan. 14, 2002

By:
Mark J. Henry
Registration No. 36,162

700 Eleventh Street, NW, Suite 500
Washington, D.C. 20001
(202) 434-1500

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Please AMEND the following claims:

2. (ONCE AMENDED) The method as claimed in claim 1, characterized in that the transmitting power interval (Pint) is defined by a maximum transmitting power (Pmax) and a minimum transmitting power (Pmin).

3. (ONCE AMENDED) The method as claimed in claim 1 [or 2], characterized in that the transmitting power interval (Pint) is defined individually for the subscriber station (UE) and/or for the base station (NB).

4. (ONCE AMENDED) The method as claimed in [a preceding claim]claim 1, characterized in that transmitting power intervals (Pint) of a number of subscriber stations (UE) which have set up connections in parallel in the same frequency band (B) and/or in the same timeslot (ts), are dimensioned in such a manner that a predetermined dynamic range of a receiving device of the base station (NB) is not exceeded.

5. (ONCE AMENDED) The method as claimed in [a preceding claim]claim 1, characterized in that the base station (NB) signals to the subscriber station (UE) the transmitting power interval (Pint) or the maximum transmitting power (Pmax) and the minimum transmitting power (Pmin) for the signal transmission in the uplink (UL).

6. (ONCE AMENDED) The method as claimed in [a preceding claim]claim 1, characterized in that the transmitting power interval (Pint) is dimensioned in dependence on a service transmitted over the link between the base station (NB) and the subscriber station (NB).

7. (ONCE AMENDED) The method as claimed in [a preceding claim]claim 1, characterized in that the transmitting power interval (Pint) is dimensioned in dependence on a speed (V) of the subscriber station (UE).

8. (ONCE AMENDED) The method as claimed in [a preceding claim]claim 1, characterized in that the transmitting power interval (Pint) is progressively reduced with increasing speed (V) of the subscriber station (UE).

9. (ONCE AMENDED) The method as claimed in claim 7 [or 8], characterized in that the speed (V) of the subscriber station (UE) is estimated from measurements with respect to a variation of transmission characteristics of the radio interface, the transmission characteristics being determined by means of a characteristic value (BER).

10. (ONCE AMENDED) The method as claimed in [the preceding claim]claim 9, characterized in that a bit error rate, a time frame error rate, a path attenuation and/or an interference at the location of the subscriber station (UE) is determined as the characteristic value (BER) for the transmission characteristics.

11. (ONCE AMENDED) The method as claimed in claim 9 [or 10], characterized in that the variation of the characteristic value (BER) of a signaling channel (BCCH) transmitted with constant transmitting power by the base station (NB) is determined in the subscriber station (UE).

12. (ONCE AMENDED) The method as claimed in [one of claims 9 to 11]claim 9, characterized in that the characteristic value (BER) is averaged over a particular time interval and the averaged characteristic value (BERavg) is taken into consideration for the dimensioning of the transmitting power interval (Pint).

13. (ONCE AMENDED) The method as claimed in [the preceding claim]claim 12, characterized in that the time interval for averaging corresponds to a periodicity of the slow transmitting power control in the outer control loop.

14. (ONCE AMENDED) The method as claimed in [one of claims 9 to 13]claim 9, characterized in that an updating of the dimensioning of the transmitting power interval (Pint) is initiated when the variation of the transmission characteristics of the radio interface determined drops below a predetermined threshold value.

15. (ONCE AMENDED) The method as claimed in [a preceding claim]claim 1, characterized in that the fast and/or slow transmitting power control for the uplink (UL) and/or for the downlink (DL) are based on the determination of a carrier/interference ratio (CIR).

16. (ONCE AMENDED) The method as claimed in [one of claims 9 to 15]claim 9, characterized in that the characteristic value (BER) determined is compared with a target BER in the outer control loop and a difference (dBER) between the values is calculated.

17. (ONCE AMENDED) The method as claimed in [the preceding claim]claim 16, characterized in that the difference (dBER) between the characteristic value (BER) determined and the target BER is weighted by a weighting factor (g).

18. (ONCE AMENDED) The method as claimed in [the preceding claim]claim 17, characterized in that the weighted difference (dCIR) is added to a target CIR(i) of a preceding control interval (i) from which the current target CIR, CIR(i+1) for the current control interval (i+1) is determined.

19. (ONCE AMENDED) The method as claimed in [the preceding claim]claim 18, characterized in that the outer control loop for the subscriber station (UE) is also implemented in the base station (NB), in which arrangement an in each case current target CIR is generated in the outer control loop from a current characteristic value (BER) determined by the subscriber station (UE) and signaled to the base station (NB), and is signaled to the subscriber station (UE).

20. (ONCE AMENDED) The method as claimed in [a preceding claim]claim 1, characterized in that the radio communications system supports a TDD transmission method.

21. (ONCE AMENDED) The method as claimed in [one of claims 1 to 19]claim 1, characterized in that the radio communications system supports an FDD transmission method.

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Description

Method for controlling the transmitting power in a radio communications system

The invention relates to a method for controlling the transmitting power in a radio communications system, particularly a mobile radio system.

In radio communications systems, for example the second-generation European mobile radio system GSM (Global System for Mobile Communications), information such as, for example, voice, image information or other data is transmitted with the aid of electromagnetic waves via a radio interface. The radio interface relates to a link between a base station and a multiplicity of subscriber stations, where the subscriber stations can be, for example, mobile stations or stationary radio stations. The electromagnetic waves are radiated by means of carrier frequencies which are within a frequency band provided for the respective system. For future radio communications systems, for example the UMTS (Universal Mobile Telecommunication System) or other third-generation systems, frequencies are provided in the frequency band of approx. 2000 MHz. For the third mobile radio generation UMTS, two modes are provided, one mode designating FDD (Frequency Division Duplex) operation and the other mode designating TDD (Time Division Duplex) operation. These modes are used in different frequency bands, both modes supporting a so-called CDMA (Code Division Multiple Access) subscriber separation method.

In mobile radio systems using subscriber separation based on a CDMA method, fast power control, particularly of the mobile radio stations, is necessary

in order to ensure reliable reception of all existing communication links at the location of the base station with at the same time little disturbance due to interference from adjacent transmission channels. Fast transmitting power control is required, in particular, for real-time services such as voice transmission at low rates. According to the prior art as disclosed, for example, in the document ARIB "Japan's Proposal for Candidate Radio Transmission Technology on IMT-2000:W-CDMA", June 1998, Japan, pp. 39 to 42, fast transmitting power control based on a closed control loop and an open control loop is implemented for the FDD mode. Whether the open control loop or closed control loop is used depends on the type of the respective transmission channel. The fast closed control loop is based on so-called TPC (Transmitter Power Control) bits which are periodically signaled by the facility of the radio communications system which has the control in each case to the other facility. Thus, a base station controls the transmitting power of the subscriber station and vice versa.

For the purpose of harmonization between the two modes of the UMTS mobile radio system, such a principle of transmitting power is also to be used, in principle, for the TDD mode. However, simulations have shown that, for example at a subscriber station speed of greater than 10 km/h, fast transmitting power control brings no further gain with respect to an interference situation at the location of the receiving radio station but, in contrast, can even be disadvantageous. The same result also applies to the FDD mode.

From WO 99/18702, a method for power control is known in which an inner loop increases or decreases, respectively, the transmitting power by means of a

measured transmission quality, an outer loop specifying threshold values for the signal quality.
Both the inner loop and the outer loop are arranged as a common block in the base station and/or with the subscriber.

From Sampath A. et al.: "On settings reverse link target SIR in a CDMA system" Phoenix, May 4-7, 1997, New York, IEEE, US. Vol. Conf. 47, 4th May 1997 (1997-05-04), pages 929-933, XP000736744 ISBN:0-7803-3660-7, a method for power control is known in which a subscriber is requested by a base station to adapt his transmitting power, this request being based on a measured signal-to-interference ratio (SIR) value. The control loop itself consists of an inner loop and an outer loop, the inner loop performing the power control and the outer loop being responsible for setting or determining a value which corresponds to the SIR value. The outer loop sets the target values for the inner loop.

The invention is based on the object of specifying a method which provides for improved transmitting power control in a radio communications system whilst avoiding the abovementioned disadvantages of the known method for transmitting power

control. This object is achieved by means of the method having the features of claim 1. Advantageous further developments of the invention can be found in the subclaims.

According to the invention, the transmitting power of a radio station is varied by means of an inner control loop for fast transmitting power control within a transmitting power interval predetermined for slow transmitting power control by an outer control loop. This control can be carried out both for a subscriber station and for a base station of the radio communication system.

The method according to the invention advantageously provides that a transition, for example from fast to slow transmitting power control can be carried out by dimensioning the transmitting power interval of the outer control loop, in order to implement transmitting power control by means of the slow outer control loop, for example at higher speeds of the subscriber station, whereas the fast inner control loop is used at low speeds of the subscriber station. In this exemplary case, the influence of the slow transmitting power control on the fast transmitting power control increases with increasing speed of the subscriber station until a point is reached at which the transmitting power interval becomes zero. From this point on, the transmitting power is exclusively determined by the slow transmitting power control. This method can be advantageously used, for example, both in the TDD mode and in the FDD mode of the UMTS mobile radio system.

Exemplary embodiments of the invention will be explained in greater detail by means of the attached

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drawings, in which

figure 1 shows a block diagram of a radio communications system, particularly of a mobile radio system,

figure 2 shows a diagrammatic representation of the structure of a TDD radio interface,

figure 3 shows a diagrammatic representation of the signaling between a subscriber station UE and a base station NB with a transmitting power control according to the invention,

figure 4 shows a block diagram of an exemplary implementation of the inner and outer control loop in a transceiver device of a base station or, respectively, of a subscriber station,

figure 5 shows a representation of the relationship between the weighting factor d, a characteristic value BER determined and a carrier/interference ratio CIR with respect to the outer control loop of figure 4, and

figure 6 shows an exemplary dimensioning of transmitting power intervals for a number of subscriber stations within a certain dynamic range.

Figure 1 shows a part of a mobile radio system as an example of the structure of a radio communications system. A mobile radio system in each case consists of a multiplicity of mobile switching centers MSC which belong to a switching subsystem (SSS) and are networked together or, respectively, establish access to a fixed network, and of in each case

one or more base station subsystems (BSS) connected to these mobile switching centers MSC. A base station subsystem BSS, in turn, has at least one RNC (Radio Network Controller) facility for assigning radio resources and at least one base station NB (node B) in each case connected thereto. A base station NB can set up connections to subscriber stations UE (User Equipment) such as, e.g. mobile stations or other mobile and stationary terminals, via a radio interface. Each base station NB forms at least one radio cell Z. As a rule, the size of the radio cell is determined by the range of a general signaling channel (BCCH - Broadcast Control Channel) which is transmitted with an in each case maximum and constant transmitting power by the base stations NB1, NB2. With sectorization or with hierarchical cell structures, a number of radio cells can also be supplied for each base station NB. The functions of this structure can be transferred to other radio communications systems in which the invention can be used.

The example of figure 1 shows a subscriber station UE which is constructed as a mobile station and which moves with a speed V in the radio cell Z of the base station NB. The subscriber station UE has set up a connection to the base station NB over which the signal of a selected service is transmitted in the uplink UL and downlink DL. During the call, the subscriber station UE periodically evaluates transmission characteristics of the radio interface to the base station supplying it and to other base stations NB surrounding the subscriber station UE in order to request an increase in transmitting power from the base station NB in the case of a worsening of the transmission quality or, for example, a handover to an adjacent base station. The same applies in the case

of an improvement in the quality of transmission when a possible lowering of the transmitting power is signaled in order to minimize the interference in the radio cell.

The subscriber station UE controls the transmitting power of the base station NB by means of signaling messages in which it specifies, for example, a measured variation of the transmission characteristics by specifying a variation of a characteristic value BER or its average value BERavg averaged over a time interval. The time interval selected for forming the average can be, for example, the periodicity of the outer control loop. The characteristic value BER will be, for example, a bit error rate, a time frame error rate, a path attenuation, an interference situation at the location of the subscriber station UE and combinations of these parameters. The variation of the characteristic value BER can be determined additionally or alternatively also by means of the general signaling channel BCCH transmitted at a constant transmitting power. The same method for controlling the transmitting power of the subscriber station UE is carried out by the base station NB. After appropriately evaluating the transmission characteristics, it signals an increase or decrease in transmitting power to the subscriber station UE. According to the prior art mentioned in the introduction, this signaling is carried out, for example, by a specific TPC (Transmitter Power Control) bit for the FDD mode of the ARIB.

The frame structure of the radio transmission in the TDD mode of the UMTS mobile radio system in which the method according to the invention can be advantageously used can be seen in figure 2. According to a TDMA (Time Division Multiple Access) component, a division of a broadband frequency range into a number of timeslots ts of the same period, for example 16 timeslots ts0 to

ts16, is provided which form a time frame fr.

A frequency band B extends over a particular frequency range. Some of the timeslots are used for transmitting signals in the downlink DL and some of the timeslots for transmitting signals in the uplink UL. An asymmetry ratio of 3:1 in favor of the downlink DL is shown by way of example. In this TDD transmission method, the frequency band B for the uplink UL corresponds to the frequency band B for the downlink DL. The same is repeated for other carrier frequencies. A large variety of asymmetric resource allocations can be performed by means of the variable allocation of the timeslots ts for uplink or downlink UL, DL.

Within the timeslots ts, information of a number of links is transmitted in bursts. The data d are spread individually for each connection with a fine structure, a spreading code c, so that at the receiving end, for example, n connections can be separated by this CDMA (Code Division Multiple Access) component. Spreading individual symbols of the data d has the effect that Q chips of duration T_{chip} are transmitted within the symbol period T_{sym}. The Q chips form the connection-related spreading code c.

The parameters of the radio interface used for both transmission modes are advantageously:

Chipping rate:	4.096 Mcps
Frame period:	10 ms
Number of timeslots:	16
Period of one timeslot:	625 µs
Chips per timeslot:	2560
Spreading factor:	variable
Type of modulation:	QPSK
Bandwidth:	5 MHz
Frequency reuse value:	1

These parameters provide for the best possible harmonization of the TDD mode and the FDD mode for the 3rd-generation mobile radio.

Figure 3 shows by way of example the signaling between the subscriber station UE and the base station NB in the embodiment of the method according to the invention. As will also be explained with respect to figure 4 in the text which follows, the outer control loop in the base station NB is used both for controlling the transmitting power of the base station NB and for controlling the transmitting power of the subscriber station UE.

The subscriber station UE conducts measurements with respect to the transmission characteristics of the radio interface during the signal transmission in the established connection to the base station NB. As already described with respect to figure 1, these measurements relate to, for example, a determination of a variation of the characteristic value BER over a particular time interval, an interference situation at the current site of the subscriber station UE and/or a path attenuation determined. The path attenuation is determined, for example, by means of the general signaling channel BCCH since, as a rule, the subscriber station UE knows the transmitting power of this channel. The interference and the path attenuation can be averaged over a time interval in accordance with the characteristic value BER and the respective average values can be signaled to the base station NB where they are evaluated in the outer control loop.

According to the method according to the invention, in addition to an average transmitting power a respective transmitting power interval Pint and a target carrier/interference ratio (CIR) for the base station NB and the subscriber station UE are determined, and signaled

in each case, in the outer control loop of the basestation NB. The

target CIR ensures adequate transmission quality and must be correspondingly adapted to the current transmission conditions. The respective inner control loop can perform rapid transmitting power control within the transmitting power interval Pint determined and signaled. This rapid transmitting power control is effected via the abovementioned TPC bits which in each case result in an increase or reduction of the transmitting power by a certain value in dB. The transmitting power interval Pint can be signaled as an absolute value or as a value of a maximum transmitting power Pmax and a minimum transmitting power Pmin or, respectively, as a relative value with respect to the average transmitting power.

Figure 4 shows by way of example an implementation of the combination of an inner control loop and outer control loop according to the invention in a transceiver device of the base station NB or also the subscriber station UE. In principle, the structure corresponds to the structure of figure 3.5-5, on page 40 of the abovementioned prior art of the ARIB. The received signals are filtered in a so-called matched filter MF and supplied to a detector device JDD. In the example, the detector device JDD is constructed as a known joint detection detector. This detector device JDD has only a limited dynamic range within which it can detect parallel signals, separated by spreading codes, of a number of sources. Among other things, it is for this reason that the transmitting power of the various sources must be very accurate in order to prevent this dynamic range from being exceeded and thus the quality of reception being degraded for all parallel connections.

From the detected signals, a carrier/interference ratio CIR is determined in the inner

loop. The carrier/interference ratio CIR is used as a basis for optimum transmitting power control both by the fast and the slow transmitting power control since the interference situation at the receiver represents the most important criterion for reliable reception of the signals.

The received signals are decoded in a decoding device DC following the detector device JDD, and a respective characteristic value BER is determined. This characteristic value BER is then compared with a target BER in the outer control loop and a difference dBER between the two values is calculated. The difference is then weighted by a weighting factor g and added to a target CIR(i) of a preceding control interval i. The resulting current target CIR(i+1), or target CIR, is delayed in the same manner by means of a delay device DEL and then taken into consideration for the calculation of the subsequent target value. The current target CIR is used for fast transmitting power control in the inner control loop as a basis for increasing or decreasing the transmitting power by signaling TPC bits.

In a further device of the outer control loop, the characteristic value BER is averaged. The averaging can be done, for example, over a time interval of 50 ms to 5 s for the exemplary UMTS mobile radio system. This time interval defines the periodicity for the transmitting power control of the outer control loop. According to the said prior art, fast transmitting power control is done at a periodicity of 0.625 ms. From the average BERavg of the characteristic value BER, a variation of the

transmission characteristics of the radio interface can be determined, the variation being caused, for example, by a movement of the subscriber station UE at a certain speed V. In dependence on the variation, an average transmitting power and a relative maximum transmitting power Pmax and a minimum transmitting power Pmin are then defined. The inner control loop can perform fast transmitting power control within this transmitting power interval Pint.

The maximum Pmax and minimum Pmin transmitting power can be dimensioned periodically in accordance with the time interval for averaging or for the case where the variation drops below a predetermined threshold value. As the variation of the characteristic value BER becomes smaller over the time interval, the transmitting power interval Pint is correspondingly reduced. This means, for example, that at a higher speed V of the subscriber station UE, the fast transmitting power control is progressively replaced by the slow transmitting power control since the inner control loop can no longer perform transmitting power control for a transmitting power interval Pint of zero. Thus, there is a slow transition from the fast transmitting power control to a slow transmitting power control, the limits for the absolute transition or, respectively, the point at which the transmitting power interval Pint becomes zero, being administered, for example, by the base station NB. In this arrangement, this point can also be selected in dependence on the service currently transmitted over the link or on other parameters.

The outer control loop for the subscriber station UE is implemented in such a manner that the subscriber station UE signals characteristic values currently measured BER or characteristic values averaged over a

time interval BERavg to the base

station NB. On the basis of these values, the outer control loop in the base station NB determines a target CIR for the subscriber station UE and a transmitting power interval Pint. The base station NB thus advantageously has a comprehensive capability of controlling the transmitting power control of the subscriber stations UE covered by it. At the same time, this implementation enables the complexity of the subscriber station UE to be reduced considerably since, for example, the calculation of the transmitting power limits is taken over by the central base station NB.

Figure 5 shows the relationship between the characteristic value BER and the carrier/interference ratio CIR, referring to figure 4. It becomes clear that, because of the nonlinearity of the relationship, the weighting factor g in each case depends on an operating point of the outer control loop or, respectively, on the target BER.

Figure 6 shows by way of example a respective dimensioning of the transmitting power interval Pint for connections to a number of subscriber stations UE1 to UE4. The transmitting power intervals Pint are selected in such a manner that an assumed dynamic range of 30 dB of the detector device is not exceeded. Within this dynamic range, each subscriber station UE1 to UE4 is assigned an average transmitting power with a particular transmitting power interval Pint which is in each case defined by a maximum transmitting power Pmax and a minimum transmitting power Pmin. The arrangement of the average transmitting power and of the transmitting power interval Pint within the dynamic range depends, for example, on a distance of the respective subscriber station UE1 to UE4 from the base station NB or, respectively, on individual transmission characteristics due to geographical peculiarities

at the location of the subscriber station. The width of the transmitting power interval Pint, in contrast, depends, for example, on the speed V of the respective subscriber station UE1 to UE4 and on the type of service transmitted, as described. As, for example, the speed V of the subscriber station increases, the transmitting power interval Pint is progressively reduced until it has been reduced to a point as is disclosed by the example of the third subscriber station UE3. In this case, the transmitting power is now only controlled by means of the outer control loop since the inner control loop no longer has any capability for influencing the transmitting power. The specified point for the transmitting power of this third subscriber station UE3 changes within the dynamic range in accordance with a change in the average transmitting power through the outer control loop.

Patent claims

1. A method for controlling the transmitting power in a radio communications system by using a control system consisting of an inner control loop and an outer control loop, characterized in that
   - the transmitting power of a subscriber station (UE) and/or a base station (NB) is varied by means of an inner control loop constructed for fast transmitting power control within a transmitting power interval (Pint) predetermined by an outer control loop constructed for slow transmitting power control, and in that
   - the slow transmitting power control is in each case performed in the base station (NB) by means of the outer control loop, which only exists there, both for the uplink (UL) from a subscriber station (UE) to a base station (NB) and for the downlink (DL) from the base station (NB) to the subscriber station (UE).

2. The method as claimed in claim 1, characterized in that the transmitting power interval (Pint) is defined by a maximum transmitting power (Pmax) and a minimum transmitting power (Pmin).

3. The method as claimed in claim 1 or 2, characterized in that the transmitting power interval (Pint) is defined individually for the subscriber station (UE) and/or for the base station (NB).

4. The method as claimed in a preceding claim,

characterized in that transmitting power intervals (Pint) of a number of subscriber stations (UE) which have set up connections in parallel in the same frequency band (B) and/or in the same timeslot (ts), are dimensioned in such a manner that a predetermined dynamic range of a receiving device of the base station (NB) is not exceeded.

5. The method as claimed in a preceding claim, characterized in that the base station (NB) signals to the subscriber station (UE) the transmitting power interval (Pint) or the maximum transmitting power (Pmax) and the minimum transmitting power (Pmin) for the signal transmission in the uplink (UL).

6. The method as claimed in a preceding claim, characterized in that the transmitting power interval (Pint) is dimensioned in dependence on a service transmitted over the link between the base station (NB) and the subscriber station (NB).

7. The method as claimed in a preceding claim, characterized in that the transmitting power interval (Pint) is dimensioned in dependence on a speed (V) of the subscriber station (UE).

8. The method as claimed in a preceding claim, characterized in that the transmitting power interval (Pint) is progressively reduced with increasing speed (V) of the subscriber station (UE).

9. The method as claimed in claim 7 or 8, characterized in that the speed (V) of the subscriber station (UE) is estimated from

measurements

with respect to a variation of transmission characteristics of the radio interface, the transmission characteristics being determined by means of a characteristic value (BER).

10. The method as claimed in the preceding claim, characterized in that a bit error rate, a time frame error rate, a path attenuation and/or an interference at the location of the subscriber station (UE) is determined as the characteristic value (BER) for the transmission characteristics.

11. The method as claimed in claim 9 or 10, characterized in that the variation of the characteristic value (BER) of a signaling channel (BCCH) transmitted with constant transmitting power by the base station (NB) is determined in the subscriber station (UE).

12. The method as claimed in one of claims 9 to 11, characterized in that the characteristic value (BER) is averaged over a particular time interval and the averaged characteristic value (BERavg) is taken into consideration for the dimensioning of the transmitting power interval (Pint).

13. The method as claimed in the preceding claim, characterized in that the time interval for averaging corresponds to a periodicity of the slow transmitting power control in the outer control loop.

14. The method as claimed in one of claims 9 to 13,

characterized in that an updating of the dimensioning of the transmitting power interval (Pint) is initiated when the variation of the transmission characteristics of the radio interface determined drops below a predetermined threshold value.

15. The method as claimed in a preceding claim, characterized in that the fast and/or slow transmitting power control for the uplink (UL) and/or for the downlink (DL) are based on the determination of a carrier/interference ratio (CIR).

16. The method as claimed in one of claims 9 to 15, characterized in that the characteristic value (BER) determined is compared with a target BER in the outer control loop and a difference (dBER) between the values is calculated.

17. The method as claimed in the preceding claim, characterized in that the difference (dBER) between the characteristic value (BER) determined and the target BER is weighted by a weighting factor (g).

18. The method as claimed in the preceding claim, characterized in that the weighted difference (dCIR) is added to a target CIR(i) of a preceding control interval (i) from which the current target CIR, CIR(i+1) for the current control interval (i+1) is determined.

19. The method as claimed in the preceding claim, characterized in that the outer control loop for the subscriber station (UE) is also implemented in the base station (NB), in which arrangement an in each case current target CIR is generated in the outer control loop from a current characteristic value (BER) determined by the subscriber station (UE) and signaled to the base station (NB), and is signaled to the subscriber station (UE).

20. The method as claimed in a preceding claim, characterized in that the radio communications system supports a TDD transmission method.

21. The method as claimed in one of claims 1 to 19, characterized in that the radio communications system supports an FDD transmission method.

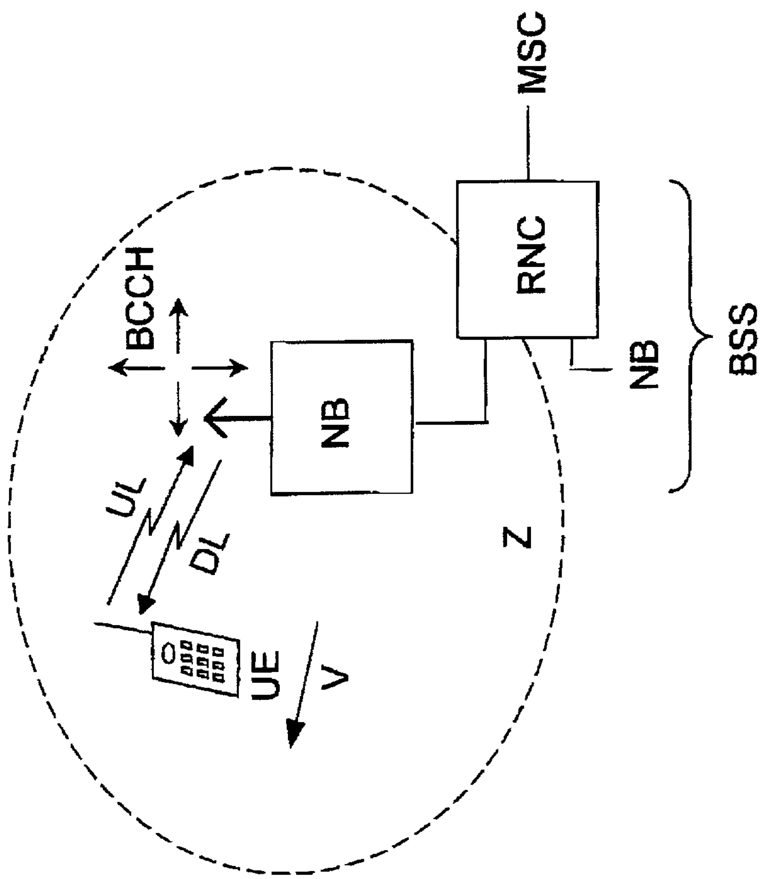


FIG 1

FIG 2

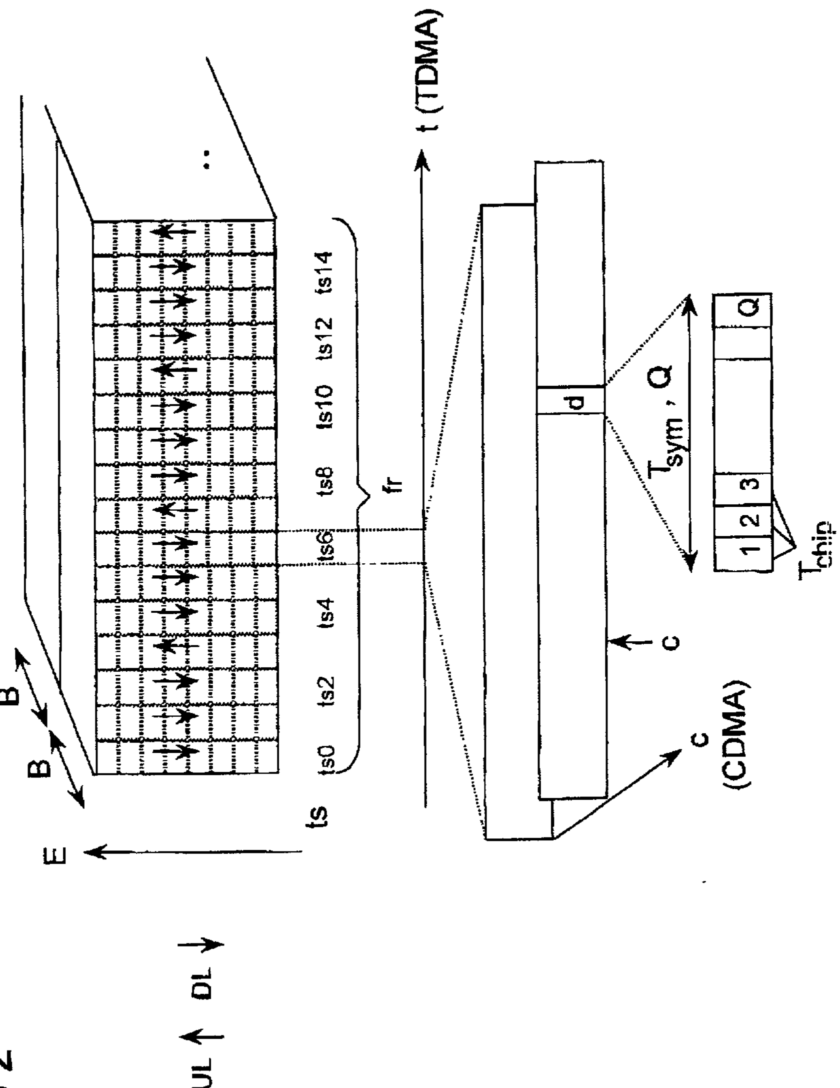
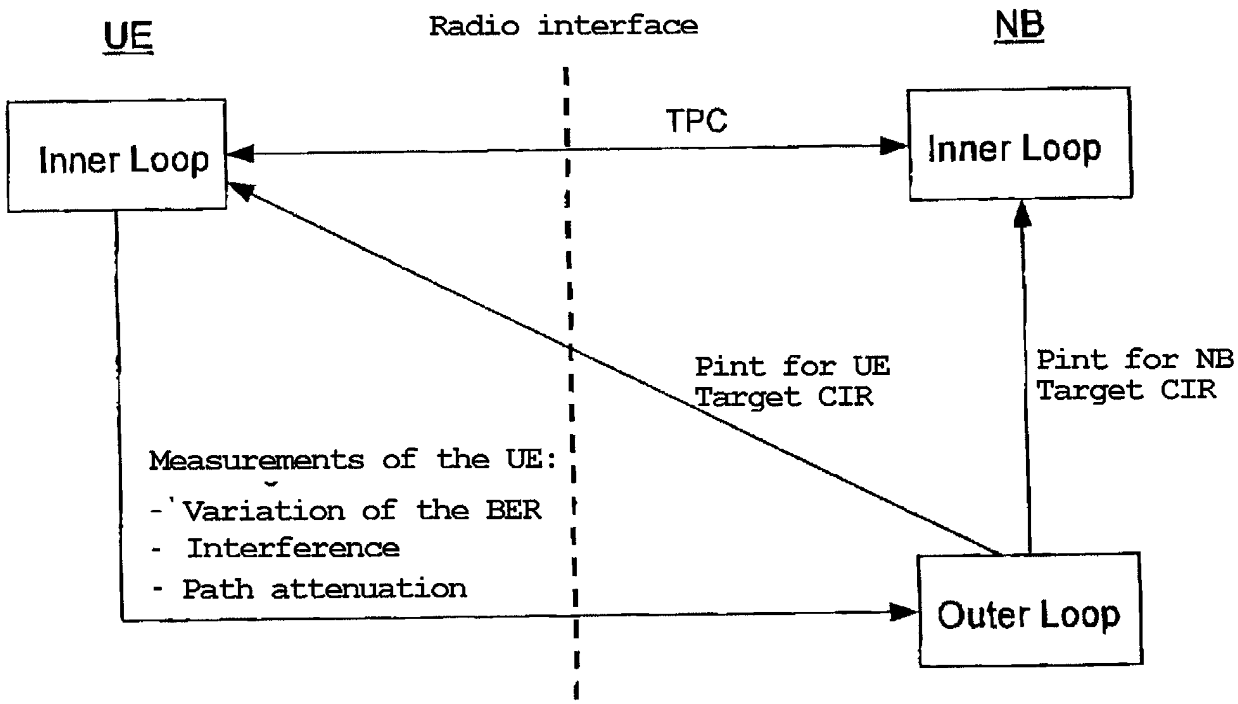

UL
DL
E
B
B
ts
ts0
ts2
ts4
ts6
ts8
ts10
ts12
ts14
fr
t (TDMA)
d
c
c
(CDMA)
T_{sym} , Q
1
2
3
Q
T_{chip}

FIG 3


UE
Radio interface
NB
Inner Loop
TPC
Inner Loop
Pint for UE
Target CIR
Pint for NB
Target CIR
Measurements of the UE:
- Variation of the BER
- Interference
- Path attenuation
Outer Loop

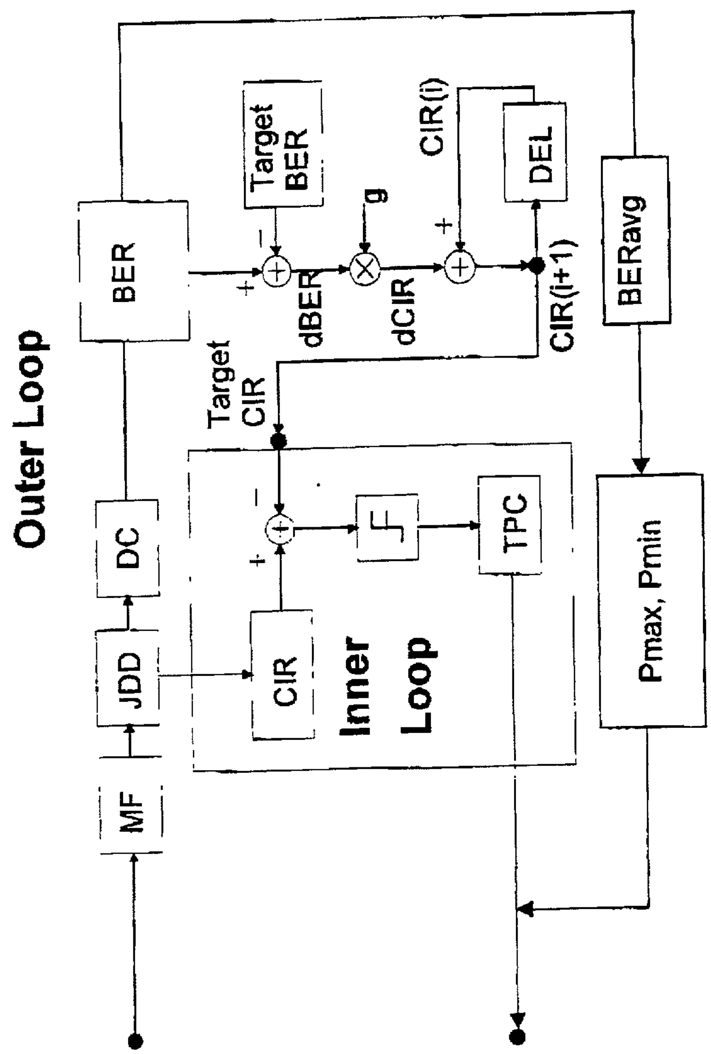
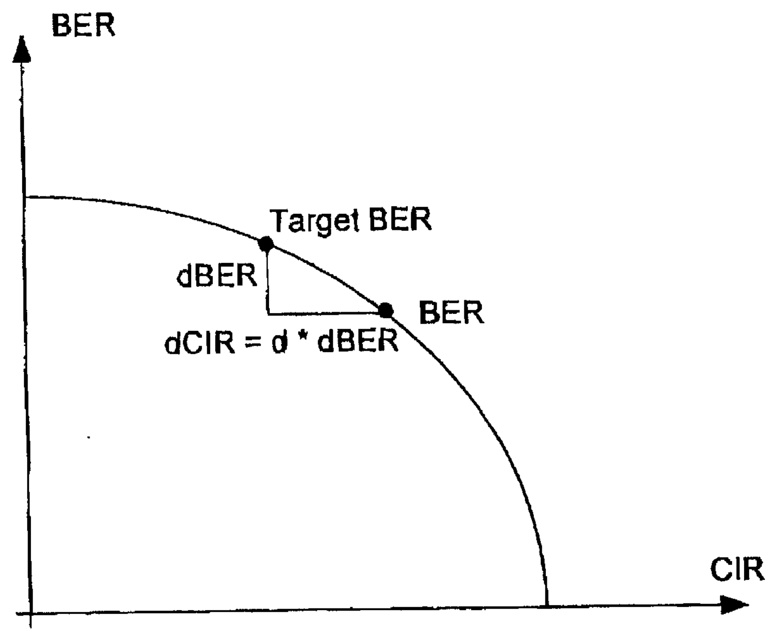
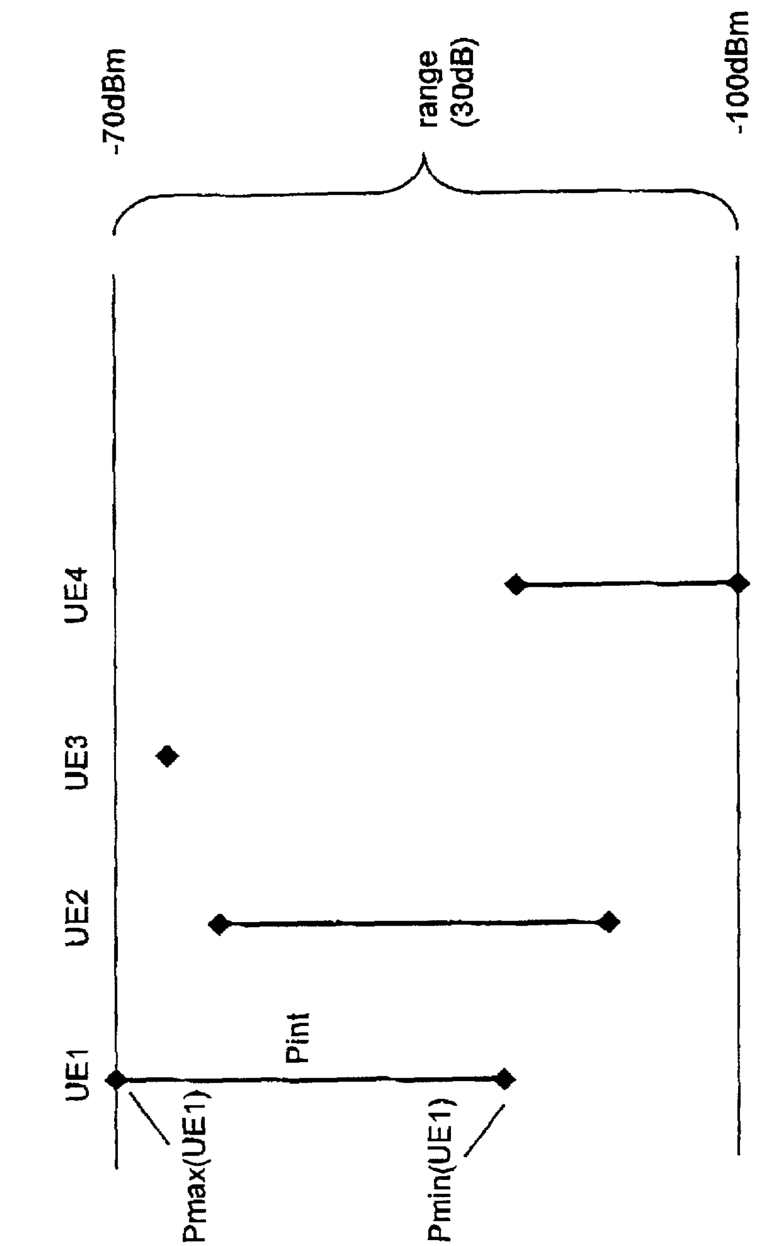

Outer Loop
BER
Target BER
g
CIR(i)
DEL
BERavg
dBER
dCIR
CIR(i+1)
Target CIR
DC
JDD
MF
CIR
TPC
Inner Loop
Pmax, Pmin
+
−

FIG 4

FIG 5





-70dBm
range (30dB)
-100dBm
UE1
UE2
UE3
UE4
Pint
Pmax(UE1)
Pmin(UE1)
P

FIG 6

Declaration and Power of Attorney For Patent Application
Erklärung Für Patentanmeldungen Mit Vollmacht
German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

As a below named inventor, I hereby declare that:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

My residence, post office address and citizenship are as stated below next to my name,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Verfahren zur Sendeleistungsregelung in einem Funk-Kommunikationssystem

Method for controlling the transmitting power in a radio communications system

deren Beschreibung

(zutreffendes ankreuzen)
☐ hier beigefügt ist.
☒ am 04.07.2000 als
PCT internationale Anmeldung
PCT Anmeldungsnummer PCT/DE00/02178
eingereicht wurde und am _______
abgeändert wurde (falls tatsächlich abgeändert).

the specification of which

(check one)
☐ is attached hereto.
☒ was filed on 04.07.2000 as
PCT international application
PCT Application No. PCT/DE00/02178
and was amended on __________
(if applicable)

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

Prior foreign appplications
Priorität beansprucht

Priority Claimed

(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
19932687.8	DE	13.07.1999	☒	☐
			☐	☐
			☐	☐

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35. United States Code. §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occured between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Serial No.) (Anmeldeseriennummer)	(Filing Date D, M, Y) (Anmeldedatum T, M, J)	(Status) (patentiert, anhängig, aufgegeben)	(Status) (patented, pending, abandoned)
PCT/DE00/02178	04.07.2000	anhängig	pending
□□□□□□□□»□□□□□□□□□□□□□□□□□□□□□□□□□□ú□□□□□□□ □□□□ □ú□□□□□□□□□□□□ú□□□□□□□□□□□□□»□□□□□□□□□□□ÂoF □□□□		(Status) (patentiert, anhängig, aufgeben)	(Status) (patented, pending, abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden koennen, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

VERTRETUNGSVOLLMACHT: Als benannter Erfinder beauftrage ich hiermit den nachstehend benannten Patentanwalt (oder die nachstehend benannten Patentanwälte) und/oder Patent-Agenten mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Geschäfte vor dem Patent- und Warenzeichenamt: *(Name und Registrationsnummer anführen)*

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

And I hereby appoint

Customer No. 21171

Telefongespräche bitte richten an: *(Name und Telefonnummer)*

Direct Telephone Calls to: *(name and telephone number)*

Ext. ______________

Postanschrift:

Send Correspondence to:

Staas & Halsey LLP
700 Eleventh Street NW, Suite 500 20001 Washington, DC
Telephone: (001) 202 434 1500 and Facsimile (001) 202 434 1501
or
Customer No. 21171

Voller Name des einzigen oder ursprünglichen Erfinders:	Full name of sole or first inventor:
MARKUS DILLINGER 18.12.01	MARKUS DILLINGER
Unterschrift des Erfinders / Datum: X Markus Dillinger	Inventor's signature / Date
Wohnsitz: MUENCHEN, DEUTSCHLAND	Residence: MUENCHEN, GERMANY DEX
Staatsangehörigkeit: DE	Citizenship: DE
Postanschrift: UNTERHACHINGER STR. 89	Post Office Addess: UNTERHACHINGER STR. 89
81737 MUENCHEN	81737 MUENCHEN

Voller Name des zweiten Miterfinders (falls zutreffend):	Full name of second joint inventor, if any:
Dr. GERALD OSTERMAYER	Dr. GERALD OSTERMAYER
Unterschrift des Erfinders / Datum: Gerald Ostermayer 7.1.2002	Second Inventor's signature / Date
Wohnsitz: A-1160 WIEN, ÖSTERREICH	Residence: A-1160 WIEN, AUSTRIA ATX
Staatsangehörigkeit: AT	Citizenship: AT
Postanschrift: KOLLBURGGASSE 2/6	Post Office Address: KOLLBURGGASSE 2/6
A-1160 WIEN	A-1160 WIEN

(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).